

Nanophotonic Applications of Silicon Carbide

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3D photonic crystals for the visible spectral range are preferably prepared from sub-micron-spheres (organic or silica) which form colloidal crystals by self-organization. However, these crystals are fragile and exhibit a low refractive index and thus are not suitable for photonic devices. Infiltration of the interparticle voids with materials of appropriate refractive index, followed by removal of the spheres, leads to inverted opals for which a complete photonic bandgap is expected. A number of materials have been infiltrated, however not all are suitable for the visible range and in addition are mechanically stable enough. Because of its easy and time-saving application at low cost infiltration by sol-gel routes is preferred. As material for infiltration we propose silicon carbide (SiC) which is a well known wide-band-gap semiconductor with extreme physical and chemical properties like high heat resistance, excellent chemical resistance, and exceptional mechanical hardness. The refractive index depends on the polytype and is at least 2.8 in the visible range. Besides infiltration via the sol-gel route SiC also allows infiltration by sublimation growth, providing high filling factors. In particular due to high synthesis temperatures an appropriate template is required. Therefore we study carbon colloidal crystals as templates, fabricated by pyrolysis of diuretics, especially melamine resin. In view of future photonic applications in-situ tuning of photonic properties becomes necessary, which might be realized by 'electronic' doping of the semiconductor material. Thus practical doping procedures for sol-gel semiconductor materials are additional requirements under investigation. Since most technological steps for SiC-based high frequency and opto-electronic semiconductor devices are well known they can be adopted. Moreover, the electronic bandgap can be adjusted according to our requirements by choosing the appropriate SiC polytype. We will present experimental details and will discuss features of silicon carbide inverted opals for photonic applications.